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Ground beetles (Coleoptera, Carabidae) from a winter excursion to Georgia, Southern Caucasus ecoregion

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Abstract

In winter 2019, an excursion to the central and eastern parts of Georgia was conducted, focusing on arboreal species and other carabids overwintering under bark or at the base of trunks. Other habitat structures were also investigated. The work was done as part of ongoing studies in preparation of a new checklist of Georgian Ground Beetles and to contribute to the faunistic as well as ecological knowledge base for the main natural areas of this country. Forty-three taxa were recorded. The arboreal species *Dromius agilis* (Fabricius, 1787), the plant-dwelling species *Demetrias imperialis* (Germar, 1823), and *Paradromius suturalis* (Motschulsky, 1844), and another six species (*Microlestes corticalis* (Dufour, 1820), *M. fissuralis* (Reitter, 1901), *M. fulvibasis* (Reitter, 1901), *M. luctuosus* Holdhaus in Apfelbeck, 1904, *Pterostichus leonisi* Apfelbeck, 1904, and *P. strenuus* (Panzer, 1796)) are new for Georgia. In some sites, the number of recorded specimens under bark, in litter, or in the upper soil was very low, probably due to specific climatic conditions (e.g., very low humidity). It is supposed that in these areas, most of the individuals reside deeper in the soil during periods of low activity or hibernation. The number of *Dromius* individuals overwintering under bark near the stem base increased with altitude. The relevance of special survey methods in the winter for ground beetles is emphasized.

Key words

Faunistics, biodiversity inventory, new records, survey methods

Introduction

Georgia is located in the Caucasus region between the Russian Federation in the north, Azerbaijan in the southeast, and Armenia and Turkey in the south. Georgia borders the Black Sea to the west. The region is considered a link between Europe and Asia and is one of the hotspots of global biodiversity (see Myers et al. 2000). Ground beetles (Carabidae) are abundantly speciose, owing to the special alpine orogeny of the area, the numerous different climatic and vegetation zones, and the various zoogeographical factors. Georgia, as the central state in the Caucasus, is of particular importance in this regard, with 720 listed species of ground beetles, including about 250 endemic taxa (Reck and Chaladze 2004; Löbl and Löbl 2017; Anichtchenko 2019; Lorenz 2022). Since the start of the 19th century, the Georgian carabid fauna has been studied both taxonomically and faunistically (e.g. Adams 1817). However, after 200 years of research, the current state of knowledge on coenoses composition and species distribution is very heterogeneous. Especially outside the Greater Caucasus, on which most sampling and research activity has focused so far, many areas have hardly or not at all been studied.

In 2017, the Working Group for Animal Ecology and Planning, in cooperation with Ilia State University and with the organizational support of the Georgian nature conser-

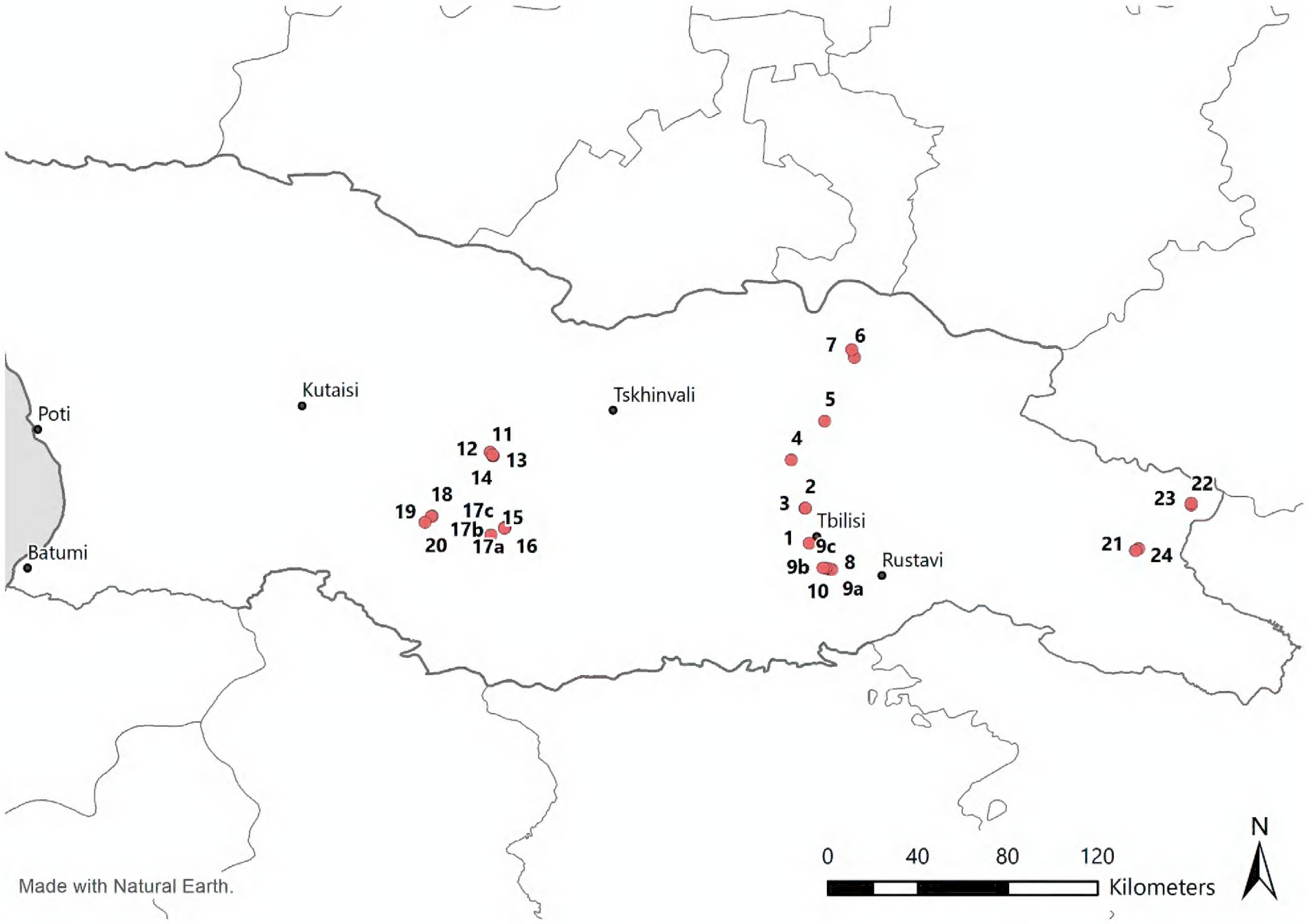

Figure 1. Map of Georgia depicting the collecting localities (red dots) during the fieldwork in winter 2019.

vation authorities, began to study Georgian landscapes in detail for their ground beetle fauna during several field trips. A selection of new and interesting records is to be published in a separate paper (Fritze et al. in preparation), and a new checklist is in preparation as well. In this context, a first winter excursion to the central and eastern parts of the country took place in December 2019. The focus was on arboreal (tree-dwelling) and other species with winter quarters, particularly at the base of the trunks of trees. Hitherto, there is hardly any data available concerning such habitat structures in Georgia.

Materials and methods

Study area and collecting localities

Encompassing an area of approx. 69.700 km², Georgia is characterized by a low degree of infrastructural development. With a population of about 3.7 million, it has a relatively low population density of about 53 people per km²; slightly more than 40% of the labor force works in agriculture (Redaktionsteam Weltalmanach 2018). Soils, vegetation, and climate zones are highly diverse and span semi-deserts and steppes in the southeast of Georgia, the subnival and nival-glacial levels of the Greater Caucasus, as well as the subtropical region of Colchis in the west with mild winters and high precipitation. Figure 1 gives an overview of the sampling localities within Georgia. A brief description of the localities is presented in Table 1 (a few of them are shown in Fig. 2). Areas with collecting localities were ecologically characterized using the typology of Nikolaishvili (2018), who, based on climate and vegetation, defines 20 landscape units for Georgia (see also Supplementary Material 2).

Collecting methods and species determination

The excursion took place from December 9 to December 19 in 2019, during which collections were made by the authors. Mostly, parts of bark or moss at the base of the trunks and in the lower trunk area (mostly up to a height of 1 or 1.5 m) were loosened and examined for ground beetles sitting underneath or between layers of bark. The capture of the animals was facilitated by the use of insect aspirators. In some cases, larger detached pieces of bark and moss were additionally searched on a white cloth, sometimes assisted by the use of a beetle sieve. At the base of the trunk, the soil substrate and litter lying close to the trunk were also searched and, in some cases, sifted through.

Hand catching and sieving were also conducted in some other habitat types (e.g. with reed beds, lying and standing dead wood, or grassland/forest ecotone). In the case of deadwood, this was dissected as much as possible in order to search inside for any hibernating individuals.

Table 1. Description of collecting localities in the central and eastern parts of Georgia during fieldwork in winter 2019. Site numbers refer to Figure 1, and landscapetype is given according to Nikolaishvili (2018) (for further definitions see Supplementary Material 2).

Site-no.	Locality	landscape type	Latitude	Longitude	Altitude
1	Tbilisi, lake Kus Tba, pine stand	6	41.700350	44.759142	720
2	Mzcheta, salt lake at Jvari Monastery, dry grassland	8	41.839314	44.742333	590
3	Mzcheta, salt lake at Jvari Monastery, oak dominated forest	8	41.838741	44.743581	600
4	Chanadirtkari, lake Bazaleti, reed bank and adjacent grazed slope	8	42.033093	44.687113	910
5	Zhinvali (North), deciduous forest	11	42.188268	44.820879	910
6	Barisakho (Southeast), pine stand	12	42.442541	44.940898	1220
7	Barisakho (East), pine stand	12	42.473635	44.930130	1340
8	Kumisi, lake Kumisi, reeds and tamarisk bushes	9	41.596395	44.840316	470
9a	Kumisi, lake Kumisi, dry grassland on hillside	9	41.594258	44.849363	500
9b	Kumisi, cultural landscape, oleaster bushes	9	41.599065	44.821104	500
9c	Kumisi, cultural landscape, trench embankment	9	41.600239	44.826326	490
10	Kumisi, lake Kumisi, willow and poplar grove	9	41.600929	44.815517	500
11	NW Surami, Chestnut forest with rhododendron undergrowth	11	42.048695	43.494299	1050
12	NW Surami, pine stand	11	42.0497	43.493983	1050
13	NW Surami, beech forest	12	42.064128	43.483203	960
14	NW Surami, pine stand	11	42.053433	43.492413	1080
15	O Bakuriani Andeziti, pine stand and succession grove	13	41.73314	43.485135	1640
16	NO Bakuriani, spruce stand (partly forest edge)	13	41.762559	43.540698	1810
17a	NO Bakuriani, solitary pines in grassland	13	41.761610	43.540354	1790
17b	NO Bakuriani, grassland and herb fringe	13	41.761663	43.539995	1780
17c	NO Bakuriani, fruit tree stand	13	41.760113	43.539303	1750
18	N Kvabiskhevi, spruce stand	12	41.808237	43.250475	1200
19	N Kvabiskhevi, pasture	12	41.806953	43.247281	1180
20	NW Kvabiskhevi, Ravine forest and stream	12	41.783674	43.221344	1040
21	S Heretiskari, Alasani-floodplain with alluvial forest	6	41.677754	46.078293	210
22	N Lagodekhi, mixed beech forest	11	41.851777	46.287632	570
23	N Lagodekhi, alluvial forest	11	41.85937	46.28831	630
24	SW Heretiskari, drained fishpond with reedbelt	6	41.669927	46.065327	130

The survey was not standardized (i.e. by plot size or collecting time). However, at least one hour was spent collecting by two people at each location.

Genital preparations were made for most species. The aedeagus was removed from the animal and transferred into 70% ethanol. Any adhering tissue and skin residue were cleaned away, and the paramers were severed. The prepared aedeagus and the paramers were then transferred into a small plastic tube containing 10% potassium hydroxide solution, tightly sealed, and macerated in a water bath at just below 100°C for three to twenty minutes (depending on size). The aedeagus was then transferred to a small bowl with 10% acetic acid (to neutralize the alkaline solution) for five hours, followed by another five hours in a small bowl with water (to wash out the acid). The genitalia were finally embedded in a water-soluble medium (Polyvinylpyrrolidon) (Lompe 1989) on a transparent label (hygrophilic-coated inkjet printing foil). The paramers were glued to the same label.

Photographs of the adult insects and the aedeagi were made with stacking equipment from the State Museum for Natural History Stuttgart and the Ecological Station of Wuerzburg University in Fabrikschleichach.

The specimens were identified using Reitter (1887, 1905), Arndt et al. (2011), Retezár (2015), and reference material from the private collections of J. Trautner and M. A. Fritze. Specimens are deposited in the aforementioned collections of these authors. Some material will be transferred later to Ilia State University (Tbilisi). The nomenclature follows Lorenz (2005), updated by information from the current Palaearctic Checklist (Löbl and Löbl 2017).

Results and discussion

Recorded species: overview

At a total of 22 of 28 investigated localities, 227 specimens were recorded, and 43 taxa were identified at the species or subspecies level (Supplementary Material 1). For two further taxa, a final determination is still pending; they are thus not considered here.

Two species, *Dromius agilis* (66 specimens at five sites) and *D. semiplagiatus* Reitter, 1887 (33 specimens at seven sites), were represented with the highest density underneath or between layers of bark. The number of specimens detected increased with increasing elevation, from 1050 to 1810 meters. *D. agilis* seems to prefer cooler and moister conditions than *D. semiplagiatus* and occurs in higher abundance even at low elevations when conditions are favorable (Site 18; Fig. 2A). In contrast, at sun-exposed sites with low tree canopy cover (site 15; Fig. 2B), *D. semiplagiatus* is more abundant.

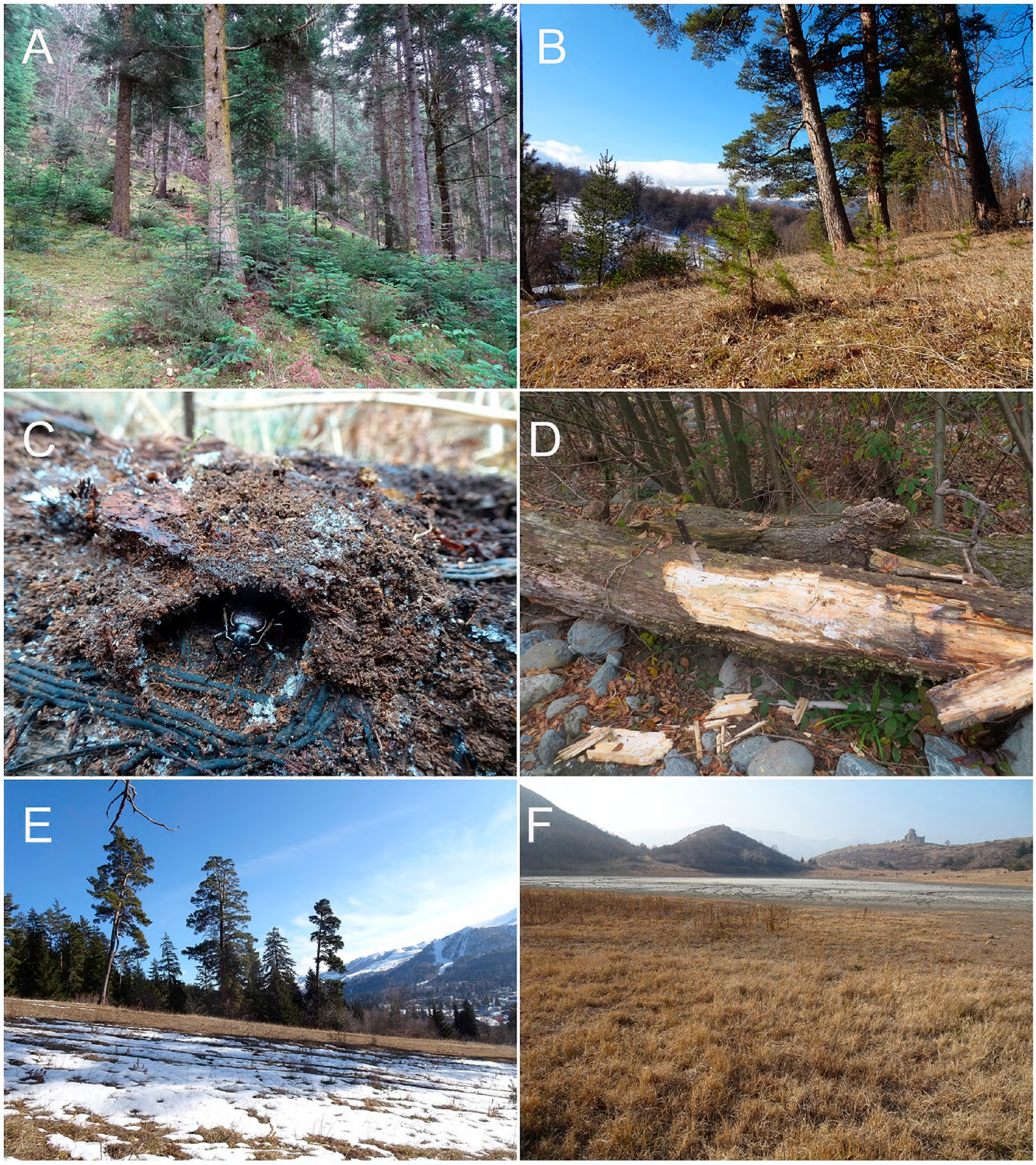

Figure 2. A: Habitat of *Dromius agilis* in Borjomi-Kharagauli National Park, site 18; **B**: Habitat of *Dromius semiplagiatus* near Bakuriani Andeziti, site 15; **C**: *Carabus varians* Fischer von Waldheim, 1823 in its winter quarter; **D**: Winter quarter and collecting site of *Tachyta nana* (Gyllenhal, 1810); **E**: Collecting site of *Olisthopus sturmii* (Duftschmid, 1812), *Lebia cruxminor* (Linnaeus, 1758) and other species (by sieving); **F**: Collecting site (image foreground) of 5 *Microlestes* species (by sieving).

Other species represented by several specimens were: *Carabus varians varians* and *C. varians armeniacus* Mannerheim, 1830 (17 specimens in single cells under loose bark of lying and standing dead logs at four sites; Fig. 2C); *Morion olympicus* L. Redtenbacher, 1843 (6 specimens); and *Tachyta nana* (9 specimens), each in a group about five cm deep in rotten wood in Lagodekhi National Park (Fig. 2D). *Syntomus truncatellus* (Linnaeus, 1760) (19 specimens) and *Olisthopus sturmii* (13 specimens) were most abundant in a grassland site (sieved samples) adjacent to herb fringe structures in the mountains near Bakuriani (site 17b; Fig. 2E). Noteworthy is the record of 10 *Microlestes* specimens from five species, three of them new for Georgia, in a dry steppe-like grassland site at Lake Jvari, northwest of Tbilisi (site 2; Fig. 2F).

Twenty-three species could only be recorded with a single specimen, and 32 species were recorded at only one site. Only parts of dead specimens of *Calosoma maderae dsungaricum* Gebler (1833) and *Taphoxenus cellarum cellarum* (M. Adams, 1817) were recorded under stones at Lake Kumisi. No ground beetles were detected at sites 1, 5, 9c, 10, 17c, or 20.

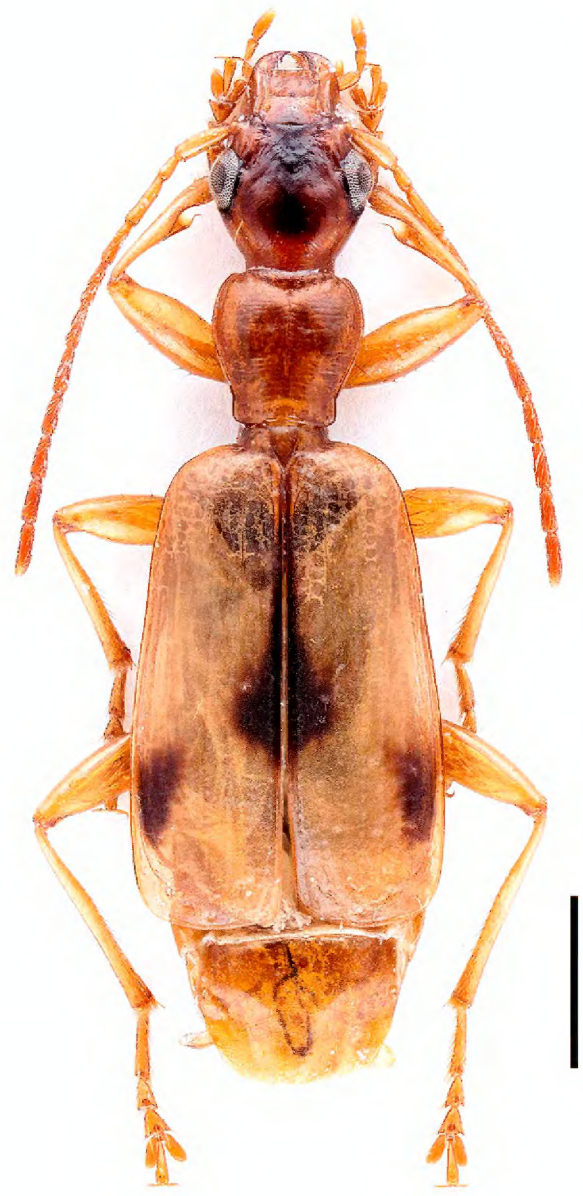

Figure 3. Dorsal view of *Demetrias imperialis* (scale bar = 1mm).

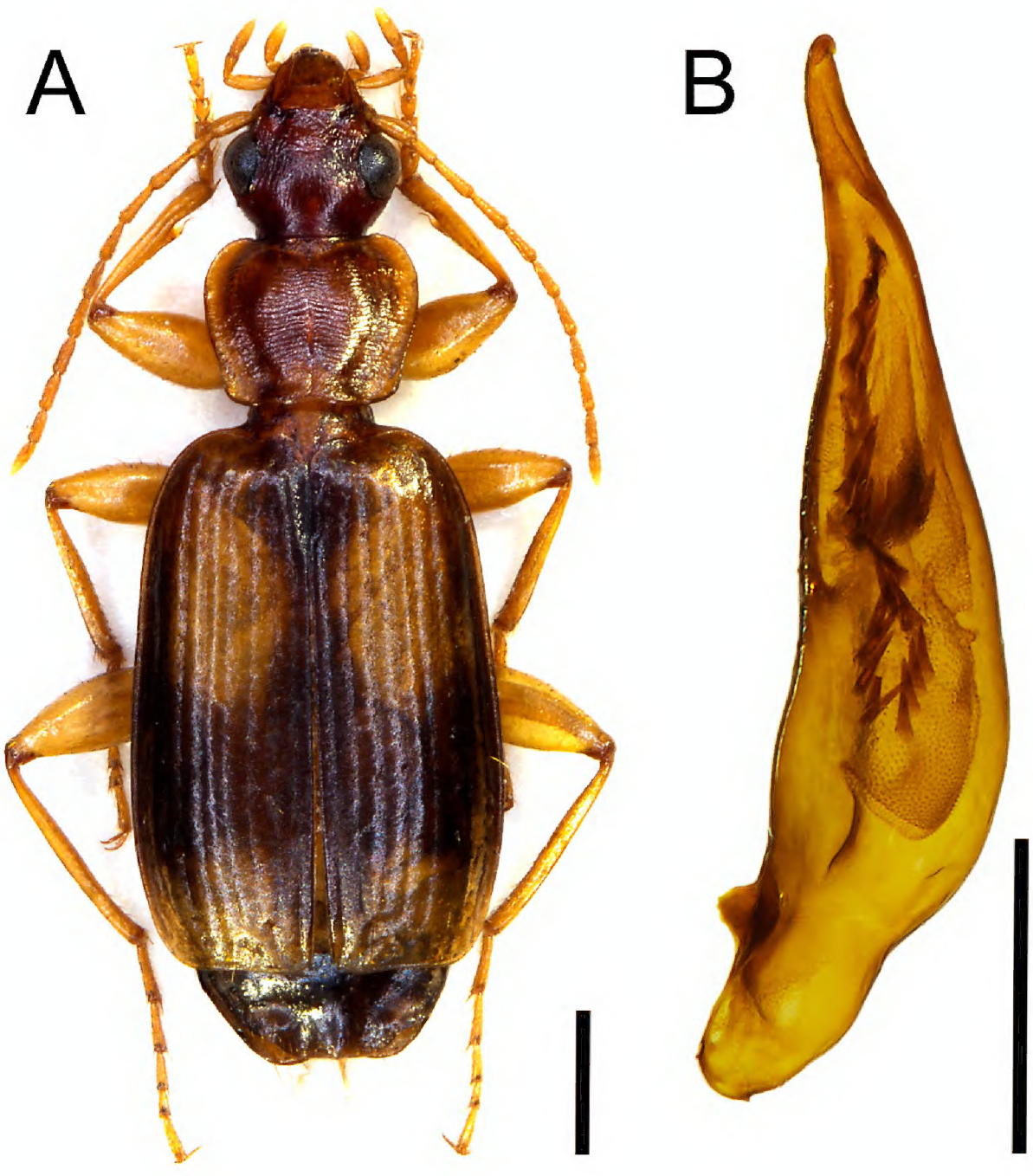

Figure 4. A: Dorsal view of *Dromius agilis* (scale bar = 1 mm); **B**: Lateral view of the median lobe of aedeagus (scale bar = 0.5 mm).

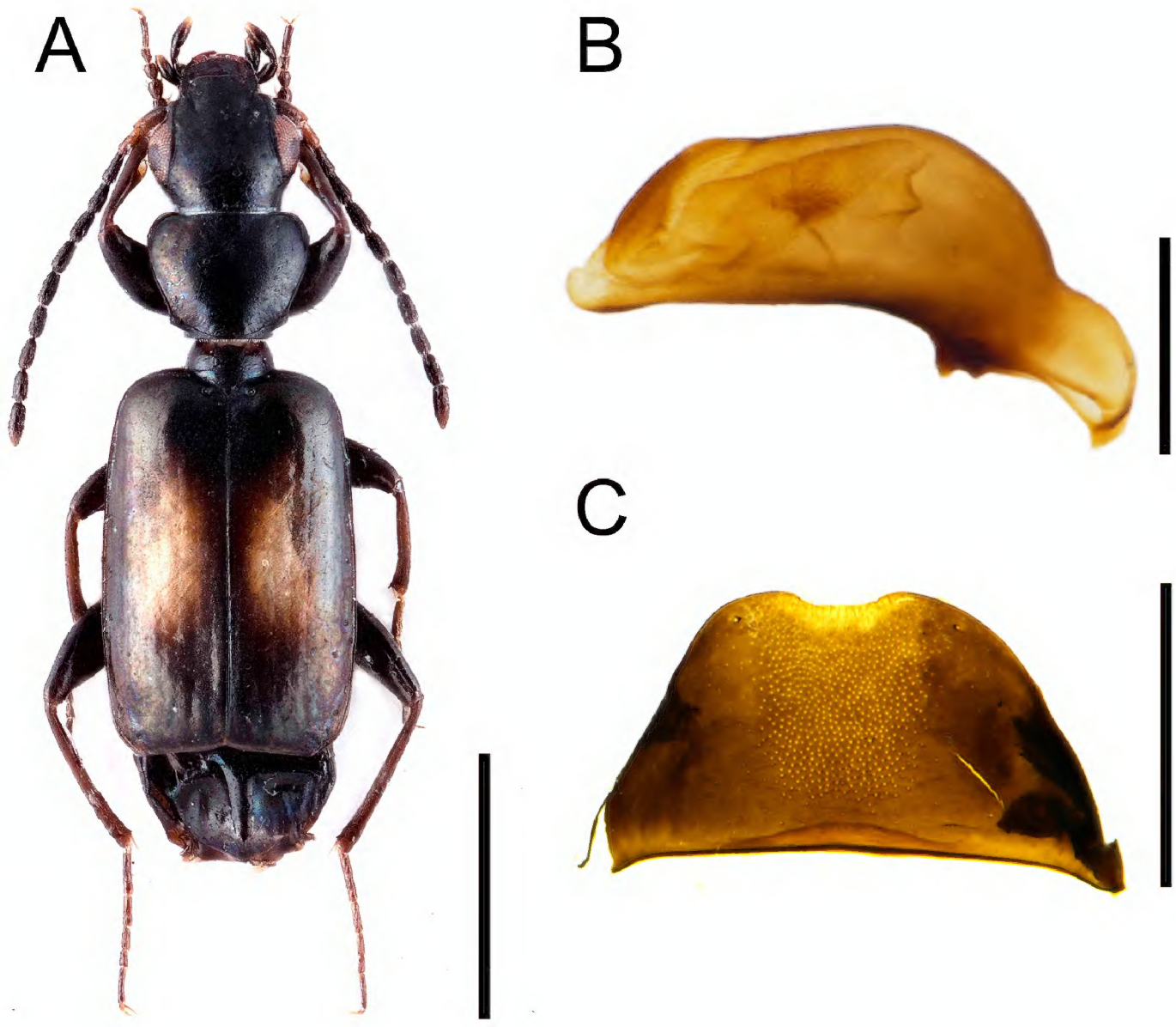

Figure 5. A: Dorsal view of *Microlestes corticalis* (scale bar = 1 mm); **B**: Lateral view of the median lobe of aedeagus (scale bar = 0.2 mm); **C**: Genital sternit (scale bar = 0.5 mm).

New species records for Georgia

The distribution status of the species was reviewed based on the work of Kryzhanovskij et al. (1995), Reck and Chaladze (2004), Löbl and Löbl (2017), and Anichtchenko (2019). Nine species were found to be new to Georgia. They are listed in alphabetical order.

Demetrias (*Aetophorus*) *imperialis* (Germar, 1823)

Turano-European species also occur in parts of northern Africa but are mostly absent in northern Europe (Müller-Motzfeld 2006; Trautner 2017). The species has been recorded in the Greater Caucasus (Kryzhanovskij et al. 1995), but was subsequently not mentioned for Georgia by either Reck and Chaladze (2004) or Löbl and Löbl (2017). The latter lists this species for the adjacent countries of Azerbaijan, southern European Russia, and Turkey. We found the species at a single location, a shallow siltation zone with a well-structured (nevertheless pronounced only over a small area) reed bed of lake Bazaleti southeast of Chanadirtkari (Site 4; Fig. 9B; Mzcheta-Mtianeti, landscape type 8 according to Nikolaishvili (2018), belonging to group "moderatly warm and semiarid"). One specimen is deposited in the collection of J. Trautner (Fig. 3).

Dromius (s. str.) *agilis* (Fabricius, 1787)

European and Sibirian-distributed species (Müller-Motzfeld 2006; Löbl and Löbl 2017). Löbl and Löbl (2017) list this species for the adjacent countries of Russia (Southern European Territory) and Turkey. The determination is based on the aedeagus illustrated in Müller-Motzfeld (2006). The coloration of the individuals found is different from that of most central European specimens; rather, they are monochromatic red-brown to brown individuals. They are rich in contrast, comparable to the taxon described as D*romius caucasicus* by Semenov (1900), later synonymized with *D. agilis*. According to our observations thus far, the species is found at altitudes above 1200 m a.s.l. and exclusively on conifers (Caucasian Fir, pine, and spruce). We found the species at five locations (Site 6, 15, 17a, 18, 26 Mzcheta-Mtianeti, Samtskhe-Javakheti, landscape, landscape type 11, 12, 13 according to Nikolaishvili (2018), belonging to the group "moderatly warm and moderately cold and humid"). Thirty-four specimens are deposited in the collection of J. Trautner, and 23 specimens are in the collection of M.A. Fritze (Fig. 4A,B).

Microlestes corticalis (L. Dufour, 1820)

Western Palaearctic species (Müller-Motzfeld 2006). The species has been recorded in the Greater Caucasus (Kryzha-

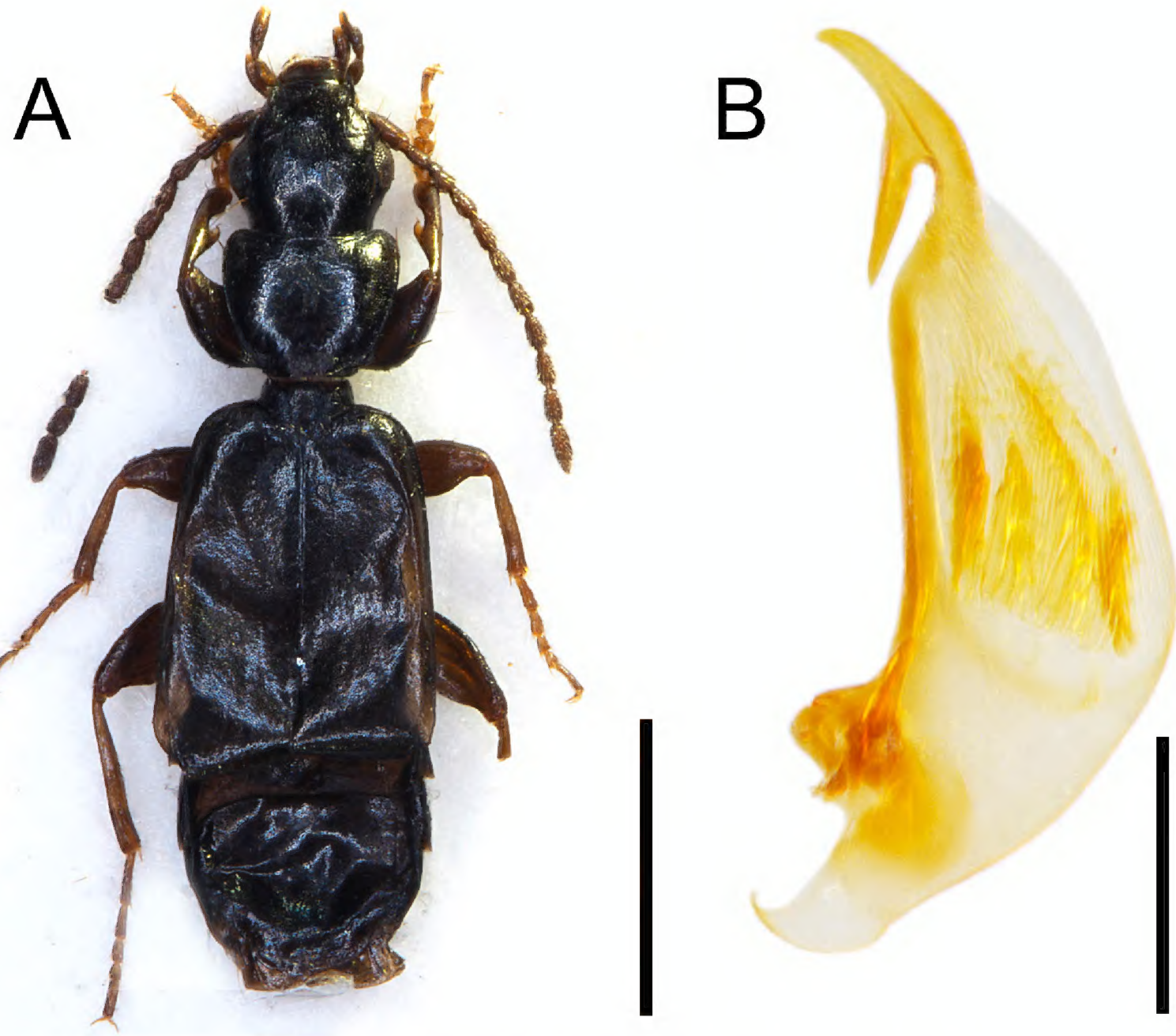

Figure 6. A: Dorsal view of *Microlestes fissuralis* (scale bar = 1 mm); **B**: Lateral view of the median lobe of aedeagus (scale bar = 0.2 mm).

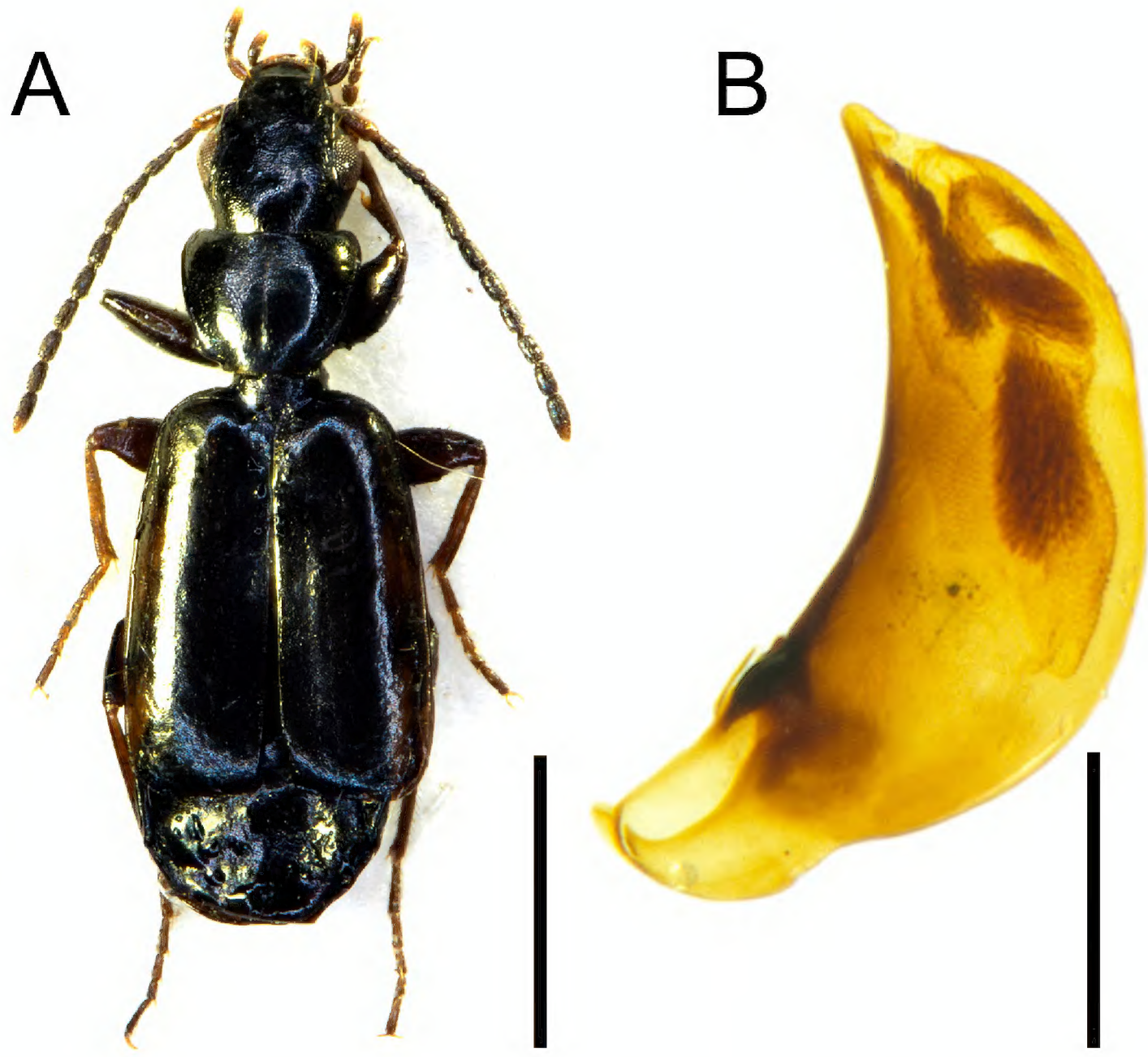

Figure 7. A: Dorsal view of *Microlestes fulvibasis* (scale bar = 1 mm); **B**: Lateral view of the median lobe of aedeagus (scale bar = 0.2 mm).

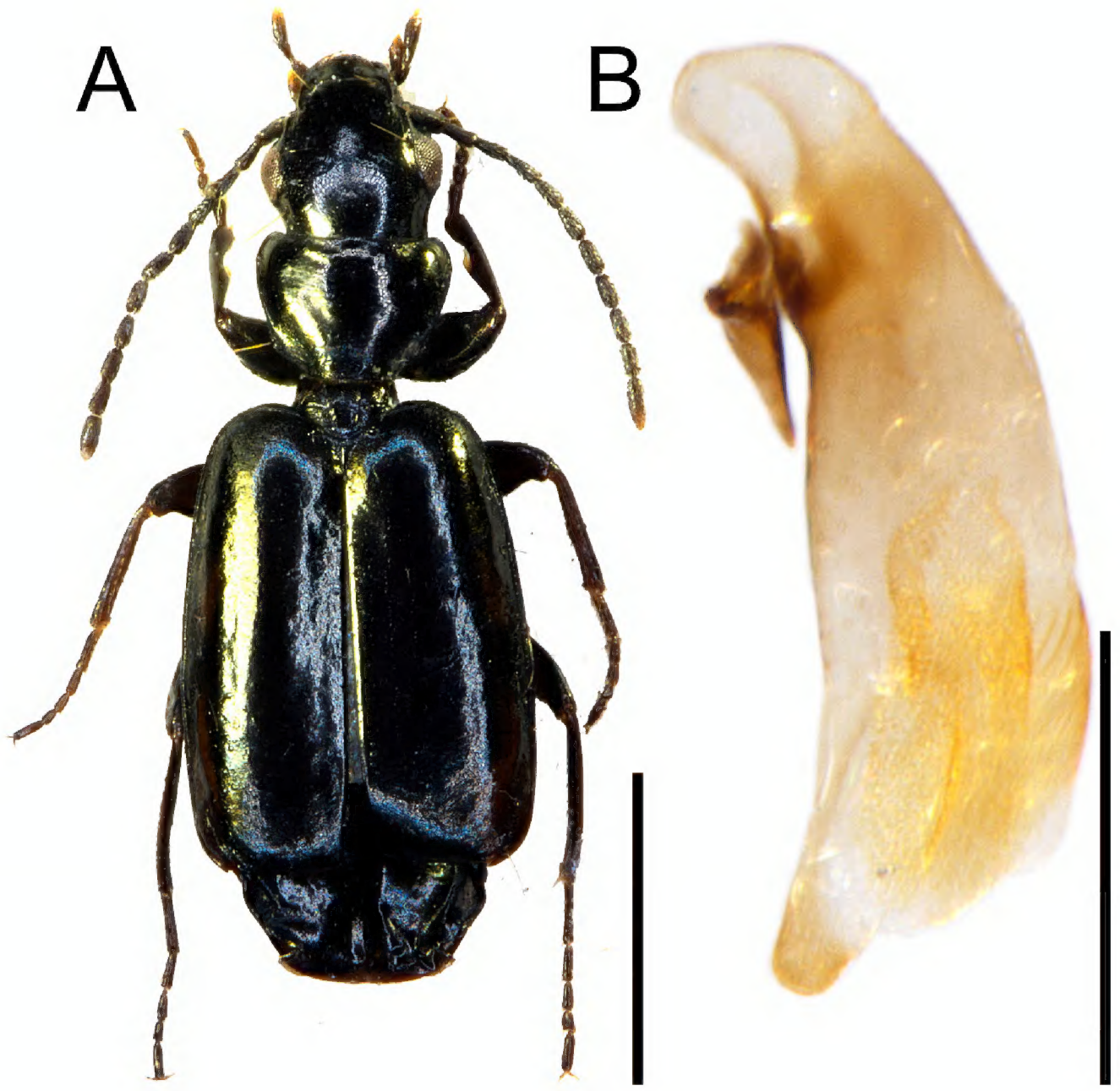

Figure 8. A: Dorsal view of *Microlestes luctuosus luctuosus* (scale bar = 1 mm); **B**: Lateral view of the median lobe of aedeagus (scale bar = 0.2 mm).

novskij et al. 1995), but was subsequently not mentioned for Georgia by either Reck and Chaladze (2004) or Löbl and Löbl (2017). The latter lists this species for the adjacent countries of Russia (Southern European Territory) and Turkey. Determination is based on characteristics of the aedeagus and of the last genital sternum, which exhibit a half-moon-shaped indent with yellow hairs in front of the posterior edge (see Arndt et al. 2011). We found the species at a single location adjacent to Lake Kumisi, vegetated with reeds and tamarisk bushes (Site 8, Mzcheta-Mtianeti, landscape type 9, according to Nikolaishvili (2018), belonging to the group "moderatly warm and semiarid"). One specimen was deposited in the collection of J. Trautner (Fig. 5A,B).

Microlestes fissuralis (Reitter, 1901)

Southeastern European to Central Siberian distribution (Müller-Motzfeld 2006). Löbl and Löbl (2017) list this species for the adjacent countries of Russia (Southern European Territory) and Turkey. The determination is based on the characteristically shaped aedeagus, with its receding hook on the underside of the tip (see Arndt et al. 2011). We found the species at a single location, dry grassland in the surroundings of the salt lake at Jvari Monastery, northeast of Tbilisi (Site 2; Fig. 2F; landscape type 8 according to Nikolaishvili (2018), belonging to group "moderatly warm and semiarid"). Two specimens were deposited in the collection of J. Trautner (Fig. 6A,B).

Microlestes fulvibasis (Reitter, 1901)

Western and Southern European, Pamiric-distributed species (Müller-Motzfeld 2006). Löbl and Löbl (2017) list this species for the adjacent countries of Azerbaijan, Russia (Southern European Territory), and Turkey. The determination is based on the aedeagus illustrated in Arndt et al. (2011). Sympatric with *M. fissuralis*. One specimen was deposited in the collection of J. Trautner (Fig. 7A,B).

Microlestes luctuosus luctuosus Holdhaus in Apfelbeck, 1904

Southern European, Pamiric-distributed species are also found in North Africa. It has been recorded in the Greater Caucasus (Kryzhanovskij et al. 1995), but was subsequently not mentioned for Georgia by either Reck and Chaladze (2004) or Löbl and Löbl (2017). Latter lists this species for the adjacent countries of Armenia, Azerbaijan, Russia (Southern European Territory), and Turkey (Löbl and Löbl 2017). The determination is based on the aedeagus illus-

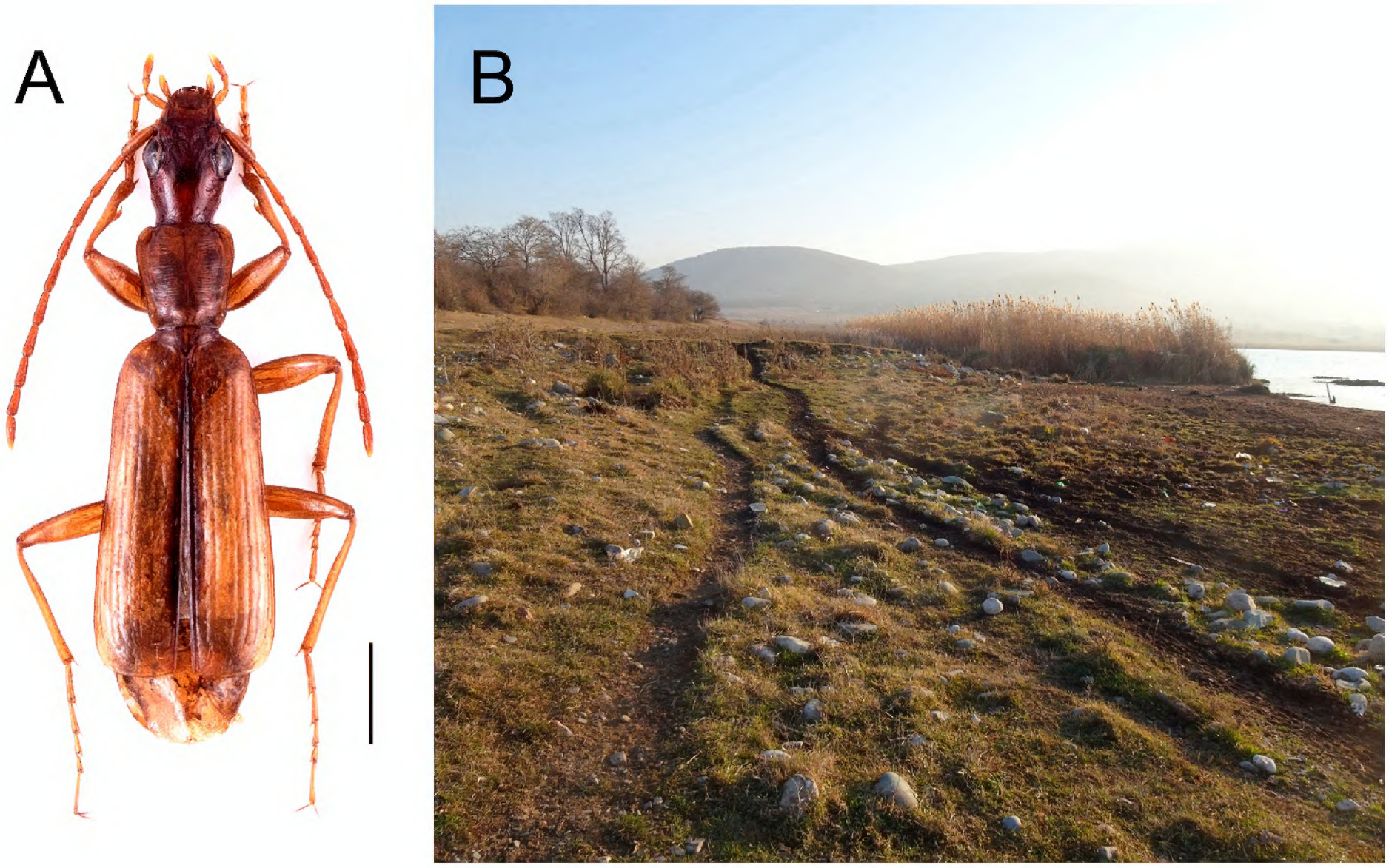

Figure 9. A: Dorsal view of *Paradromius suturalis* (scale bar = 1 mm); **B**: Habitat of *P. suturalis* at Lake Bazaleti.

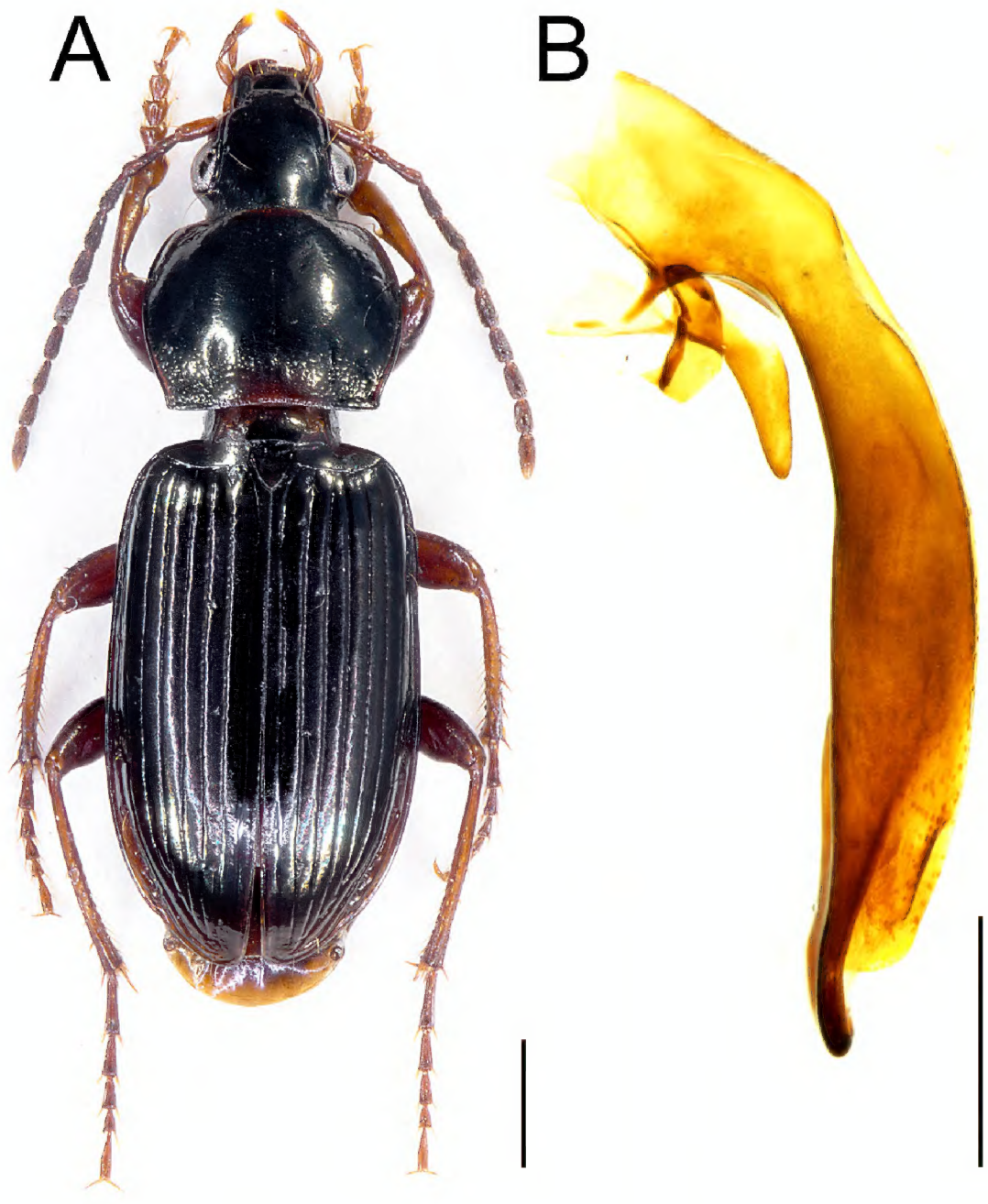

Figure 10. A: Dorsal view of *Pterostichus leonisi* (scale bar = 1 mm); **B**: Lateral view of the median lobe of aedeagus (scale bar = 1 mm).

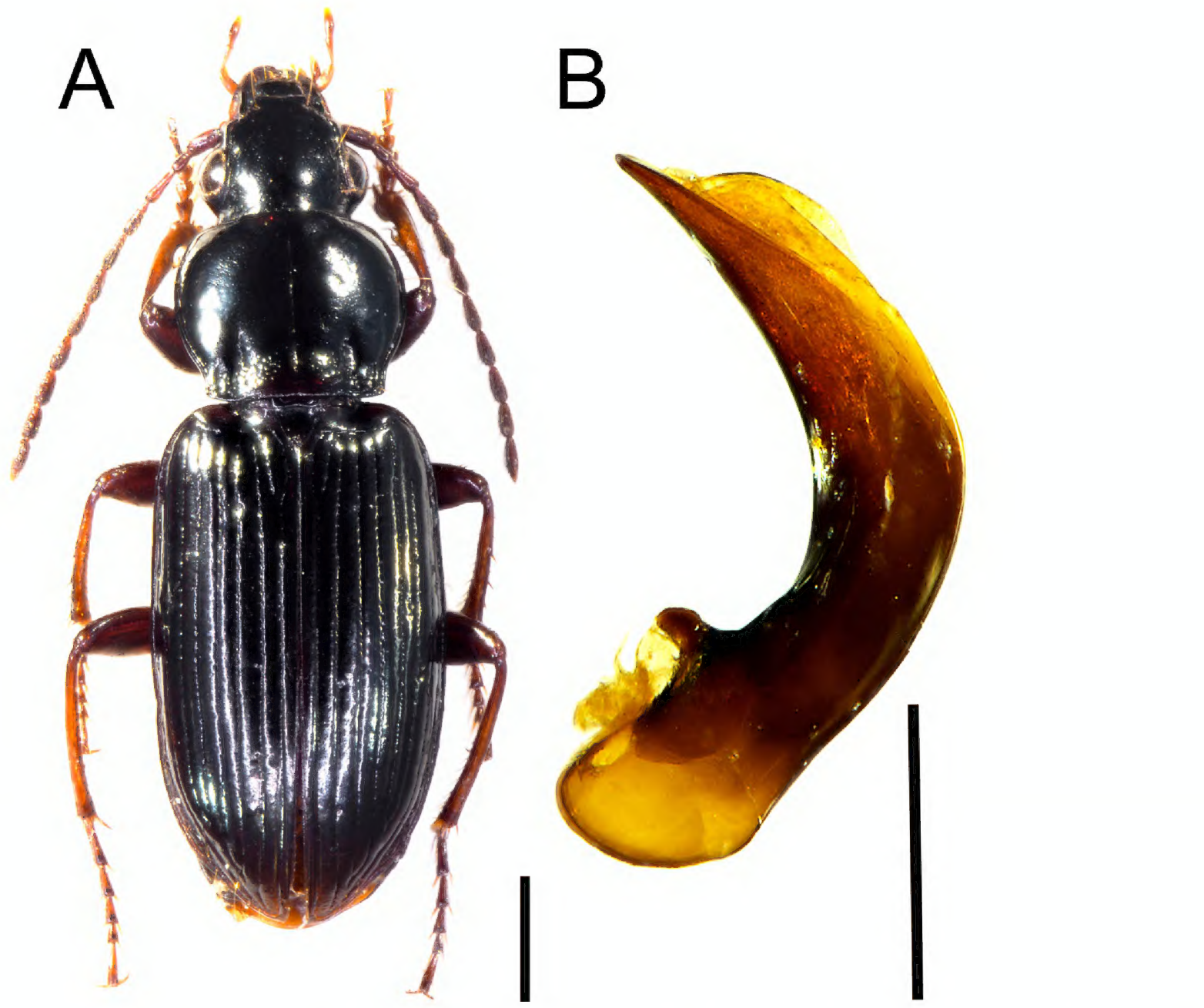

Figure 11. A: Dorsal view of *Pterostichus strenuus* (scale bar = 1 mm); **B**: Lateral view of the median lobe of aedeagus (scale bar = 1 mm).

trated in Arndt et al. (2011). Same location as *M. fissuralis*. One specimen was deposited in the collection of J. Trautner (Fig. 8A,B).

Paradromius (s. str.) *suturalis* (Motschulsky, 1844)

Transpalaearctic-distributed Eastern Palaearctic species reach Europe in Bulgaria, Greece, and the Southern Russian Plain (Khobrakova et al. 2014; Löbl and Löbl, 2017). There are only a few papers dealing with this species, mostly with a faunistic background (e. g. Lutshnik 1934; Hieke and Wrase 1988; Wrase 1991; Dudko et al. 2018). Therefore, only a little, rather vague, information on its ecology and habitat selection is known. Findings from river floodplains are reported (Khobrakova et al. 2014). Shilenkov (2010) summarized the species within a group of ground beetles living in coastal and wetland areas and highlighted marshes and shores of standing water as habitat. In contrast, Kodzhabashev and Penev (2006) name mesophilous to xerothermophilous forests as habitats, where the species occurs in leaf litter and on bark. Teofilova (2019) lists sparse vegetation and sand as habitat features. We found the species sympatric with *Demetrias imperialis* at a shallow siltation zone with a well-structured (nevertheless pronounced only over a small area) reed belt of lake Bazaleti southeast of Chanadirtkari (Site 4; Fig. 9B; landscape type 8 according to Nikolaishvili (2018), belonging to group "moderately warm and semiarid"). One specimen was deposited in the collection of J. Trautner (Fig. 9A).

Pterostichus (Argutor) *leonisi* Apfelbeck, 1904

Southeast European, Anatolian-distributed species (Müller-Motzfeld 2006). Löbl and Löbl (2017) list this species for the adjacent countries of Russia (Southern European Territory) and Turkey. The determination is based on the aedeagus illustrated in Arndt et al. (2011). Same location as *Demetrias imperialis* and *Paradromius suturalis* (Site 4; Fig. 9B; landscape type 8 according to Nikolaishvili (2018), belonging to group "moderately warm and semiarid"). One specimen was deposited in the collection of J. Trautner (Fig. 10A,B).

Pterostichus (*Phonias*) *strenuus* (Panzer, 1796)

European, Sibirian-distributed species (Müller-Motzfeld 2006). Löbl and Löbl (2017) list this species for the adjacent countries of Russia (Southern European Territory) and Turkey. We found the species at a single location, a stand of pine trees on the pass northwest of Surami (Site 14, Shida Kartli, landscape type 11, according to Nikolaishvili (2018), belonging to the group "moderatly warm and moderately cold and humid"). One specimen was deposited in the collection of J. Trautner (Fig. 11A,B).

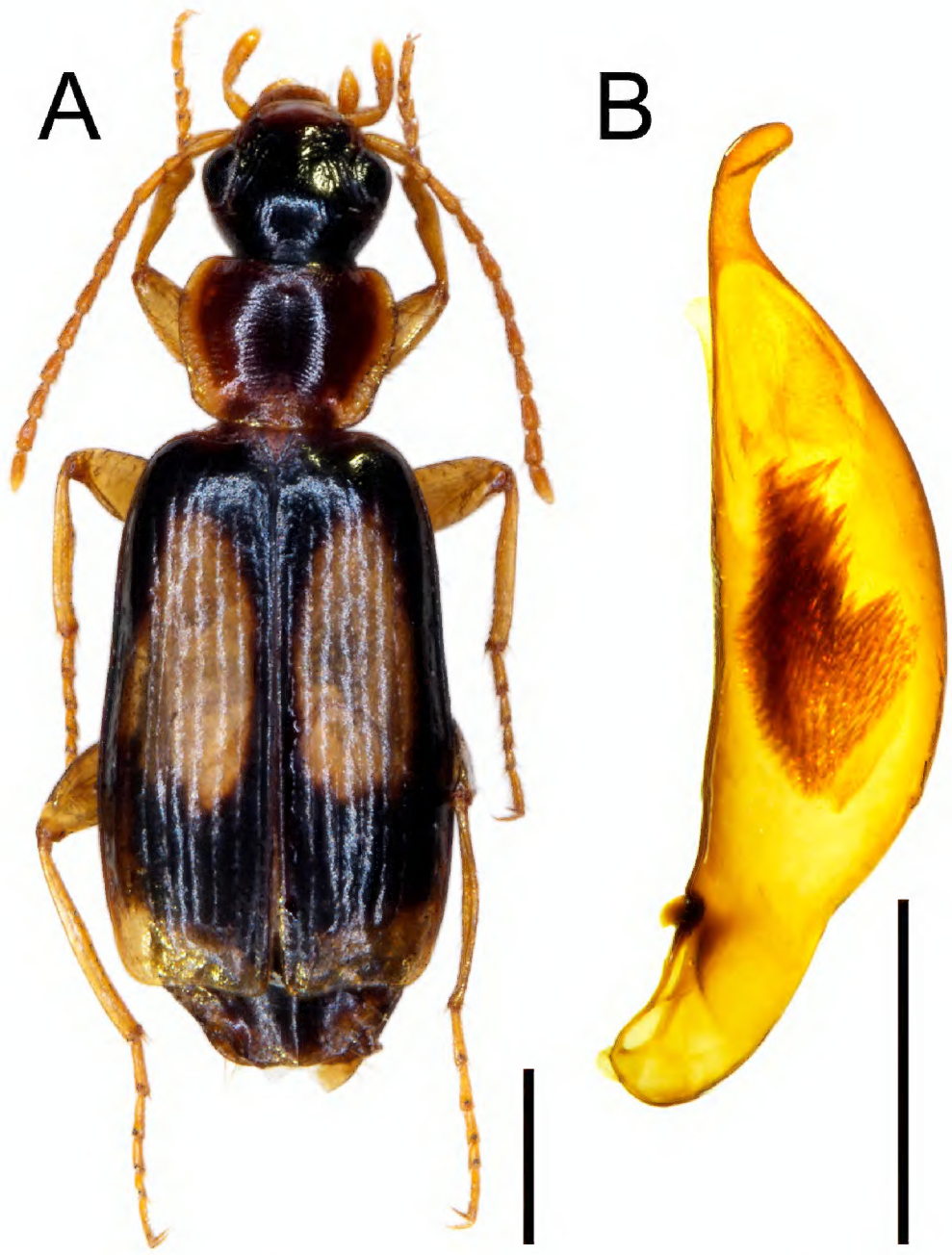

Figure 12. A: Dorsal view of *Dromius semiplagiatus* (scale bar = 1 mm); **B**: Lateral view of the median lobe of aedeagus (scale bar = 0.5 mm).

Notes on selected other species and a short outlook

According to Fritze and Trautner (2017), mating and oviposition of *Callistus lunatus* (Fabricius, 1775) in Central Europe occur mainly in spring, followed by larval development in summer. According to the carabids.org database (Homburg et al. 2014; status 2021), it should not be known yet which stage overwinters. However, according to Wradatsch (1912), the species had already been captured as an imago in winter. The finding presently made in rotten wood of a lying dead tree trunk in the Alasani floodplain south of Heretiskari (site 21) is possibly the second, or in any case, one of the few documented cases known so far.

Winter captures are well suited to detect arboricolous species, for example, the genus *Dromius*. After their activity and reproduction phase during the vegetation period, individuals of these species often aggregate at the base of the trunk, hibernate there under moss and between bark scales, and can thus be easily recorded (e. g. Trautner 1984; Simon 2001). *D. agilis* was recorded for the first time during the present excursion, while *D. semiplagiatus* was already known from Georgia (Fig. 12A,B). Both species relying exclusively on conifers. Deciduous trees in the area, however, cannot be excluded per se as habitat for arboricolous *Dromius* species, despite the fact that no specimens were found during this work. Further investigations are necessary, possibly with the use of trapping systems as successfully used in the Netherlands (see Felix and Wielink 2008).

Furthermore, the importance of winter capture is also evident for species that belong to the "plant climbers", e.g. on reeds, sedges, or other grassy and herbaceous plants (as *Paradromius* and *Demetrias* species); or that use grass stands and grassy litter as essential structures of their habitat and aggregate there according to experience (e.g. *Syntomus* and *Microlestes* species).

In total, the following genera of our winter records are classified as arboricolous, plant-climbing, or "grass-stand-affinitive", and thus almost half (20) of all species detected during the winter excursion (number of species if >1 in parentheses): *Demetrias*, *Dromius* (2), *Drypta*, *Lebia* (2), *Microlestes* (7), *Panagaeus*, *Paradromius* (2), *Philorhizus*, and *Syntomus* (3). Among them, the majority of species are newly reported for Georgia.

The largest number of individuals located were recognizably in their winter quarters, respectively, in hibernation. However, some species are known to be active in the winter, at least under particularly favorable conditions. To them belong especially *Trechus quadristriatus* (Schrank, 1781) and *Paradromius linearis* (Olivier, 1795). The individual of *Lebia cyanocephala* (Linnaeus, 1758) found was sitting directly on dry grass under a flat stone and may have been active for a short time before the capture event.

The results also underline the relevance of different investigation or collection methods and recording periods for faunistic studies on ground beetles, especially a "looking over the edge of a ground trap" approach. Method combinations are recommended in practical nature conservation

and environmental planning as well as in the field of research (e.g. Trautner 1992; Timm et al. 2008).

Interrupted by the pandemic situation in 2020, 2021, and 2022, surveys on the Georgian ground beetle fauna are to be resumed from 2023 onwards, with further field trips in the winter also planned.

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References

Adams MF (1817) Descriptio insectorum novorum Imperii Russici, inprimis Caucasi et Siberiae. Mémoires de la Société Impériale des Naturalistes de Moscou 5: 278–314.

Anichtchenko A (2019) Carabidae of the World. http://carabidae.org/countries [Accessed 20 Oct 2019]

Arndt E, Schnitter P, Sfenthourakis S, Wrase D (2011) Ground Beetles (Carabidae) of Greece. Pensoft Publishers, Sofia, Moscow, 393 p.

Dudko RY, Bespalov AN, Zinovyev EV, Lyubechanskii II (2018) Changes to the ground beetle (Coleoptera, Carabidae) fauna of the Novosibirskaya Oblast in recent decade. Euroasian Entomological Journal 17(4): 293–300. [In Russian] https://doi.org/10.15298/euroasentj.17.4.09

Felix R, Wielink P van (2008) On the biology of *Calodromius bifasciatus* and related species in 'De Kaaistoep' (Coleoptera: Carabidae). Entomologische Berichten 68(6): 198–209.

Fritze MA, Trautner J (2017) Tribus Chlaeniini. In: Trautner J (Ed.) Die Laufkäfer Baden-Württembergs Band 2. Ulmer, Stuttgart, 428–439.

Hieke F, Wrase DW (1988) Faunistik der Laufkäfer Bulgariens. Deutsche Entomologische Zeitschrift 35: 1–171. https://doi.org/10.1002/mmnd.19880350102

Homburg K, Homburg N, Schäfer F, Schuldt A, Assmann T (2014) Carabids.org – a dynamic online database of ground beetle species traits (Coleoptera, Carabidae). Insect Conservation and Diversity 7(3): 195–205. https://doi.org/10.1111/icad.12045

Khobrakova LT, Shilenkov VG, Dudko RY (2014) The ground beetles (Coleoptera, Carabidae) of Buryatia. Buryat Scientific Center SB RAS Press Ulan Ude, 379 pp. [In Russian].

Kodzhabashev ND, Penev LD (2006) The ground beetles (Coleoptera: Carabidae) of South Dobrudzha, Bulgaria. Acta Zoologica Bulgarica 58(2): 147–180.

Kryzhanovskij OL, Belousov IA, Kabak II, Kataev BM, Makarov KV, Shilenkov VG (1995) A check-list of the ground-beetles of Russia and adjacent lands (Insecta, Coleoptera, Carabidae). Pensoft Series Faunistica 3: 1–271.

Löbl I, Löbl D (2017) Catalogue of Palaearctic Coleoptera Volume 1. Archostemata-Myxophaga-Adephaga. Brill, Leiden, 1443 pp. https://doi.org/10.1163/9789004330290_002

Lompe A (1989) Ein bewährtes Einbettungsmittel für Insektenpräparate. In: Lohse GA, Lucht WH (Eds) Die Käfer Mitteleuropas 12. Goecke & Evers, Krefeld, 17–18.

Lorenz W (2005) Nomina Carabidarum: A directory of the scientific names of ground beetles: 2. Edition. Self-published, Tutzing, 1190 pp.

Lorenz W (2022) CarabCat-Checklist (version 1.0). http://carabidfauna.com/checklist.php [Accessed 30 Apr 2022].

Lutshnik VN (1934) Analecta carabidologica III. Časopsis Československé Společnosti Entomologické 31: 69–70.

Müller-Motzfeld G (2006) Bd. 2 Adephaga 1: Carabidae (Laufkäfer). In: Freude H, Harde KW, Lohse GA, Klausnitzer B: Die Käfer Mitteleuropas. Spektrum-Akademischer-Verlag, Heidelberg, 521 pp.

Myers N, Mittermeier RA, Mittermeier CG, Da Fonseca GA, Kent J (2000) Biodiversity hotspots for conservation priorities. Nature 403(6772): 853–858. https://doi.org/10.1038/35002501

Nikolaishvili D (2018) Landcsapes. In: Bolashvili N, Dittmann A, King L, Neidze V (Eds) National Atlas of Georgia. Steiner, Stuttgart, 77. https://doi.org/10.25162/9783515121835

Reck N, Chaladze G (2004) Checklist of the ground beetles (Coleoptera, Carabidae) of Georgia. Proceedings of the Institute of Zoology 22: 127–154.

Redaktionsteam Weltalmanach (2018) Der neue Fischer Weltalmanach 2019. S. Fischer Verlag, Frankfurt am Main, 736 pp.

Reitter E (1887) Übersicht der mir bekannten Arten der Col. Gattg. *Dromius* Bon. aus Europa und den angrenzenden Ländern. Wiener Entomologische Zeitung 6(10): 255–288. https://doi.org/10.5962/bhl.part.17766

Reitter E (1905) Zur systematischen Gruppeneinteilung des Coleopteren-Genus *Dromius* Bonelli. Übersicht der mir bekannten Arten. Wiener Entomologische Zeitung 24(7-8): 229–240.

Retezár I (2015) Atlas of the *Carabus* of the Caucasus (Coleoptera, Carabidae). Iconography, genital morphology, systematics and faunistics. mondAt Kft, Vác, 429 pp.

Semenov A (1900) Coleoptera nova Rossiae europaea Caucasique. VII. Horae Societatis Entomologicae Rossicae 34(1899-1900): 88–95.

Shilenkov VG (2010) Rare carabids (Coleoptera, Carabidae) of Baikalian region and the principles of preservation of insects. Journal of the Irkutsk State University Series Biology and Ecology 3(1): 37–41. [In Russian]

Simon U (2001) Vertikalverteilung und Saisonalität von Arten der *Dromius*-Gruppe an Waldkiefern (*Pinus sylvestris* L.). Angewandte Carabidologie Supplement 2: 117–122.

Teofilova TM (2019) Ground beetles (Coleoptera: Carabidae) from sparsely vegetated land ecosystems in Bulgaria. North-Western Journal of Zoology 15(1): 30–41. https://doi.org/10.35513/21658005.2020.1.4

Timm A, Dayan T, Levanony T, Wrase D, Assmann T (2008) Towards combined methods for recording ground beetles: Pitfall traps, hand picking and sifting in Mediterranean habitats of Israel. In: Penev L, Erwin T, Assmann T (Eds) Back to the roots and back to the future. Towards a new synthesis amongst taxonomic, ecolocogical, and biogeografical approaches in carabidology. Proceedings of the XIII European Carabidologists Meeting, Blagoevgrad, August 20–24, 2007: Pensoft Publishers, Sofia, Moscow, 397–408.

Trautner J (1984) Zur Verbreitung und Ökologie der *Dromius*-Arten (Coleoptera, Carabidae) in Württemberg. Jahreshefte der Gesellschaft für Naturkunde in Württemberg 139: 211–215.

Trautner J (1992) Laufkäfer – Methoden der Bestandsaufnahme und Hinweise für die Auswertung bei Naturschutz- und Eingriffsplanungen. In: Trautner J (Ed.) Arten- und Biotopschutz in der Planung: Methodische Standards zur Erfassung von Tierartengruppen [BVDL-Tagung Bad Wurzach, 9–10 November 1991]. Ökologie in Forschung und Anwendung 5: 145–162.

Trautner J (2017) Tribus Lebiini. In: Trautner J (Ed) Die Laufkäfer Baden-Württembergs Band 2. Eugen Ulmer, Stuttgart, 608-650.

Wradatsch G (1912) Über Käferfang im Winter. Wiener Entomologische Zeitschrift 31(2): 99–100.

Wrase DW (1991) Faunistik der Laufkäfer Bulgariens (Coleoptera;Carabidae). 1. Nachtrag. Mitteilungen der Schweizerischen Entomologischen Gesellschaft 41(1): 2–20.

Supplementary material 1

Authors: Traurner J et al. (2023)

Data type: .doc

Explanation note: Table S1. Ground beetles abundance data from the winter excursion, 2019 to Georgia (in alphabetical order; details on sampling sites are given in main text, Table 1).

Link: https://doi.org/10.3897/caucasiana.2.e102280.suppl1

Supplementary material 2

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Explanation note: Table S2. Descriptions of Georgian landscape types.

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